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Effect of Expansion Joints on Structural behavior of RC Framed structures

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Abstract
An Expansion joint are the crevices in the building structure gave to permit to the development of the working because of temperature changes. They are given regularly in the structures of pieces, extensions and different structures where there is a change of development of the structures because of temperature. Noteworthiness of these joints are for the most part to control the uneven surface in the structure when it is subjected to temperature changes. In present situation the originators of the structures are not considering extension joints while outlining a multi storied structures. Thought of extension joints in the outline can lessen the temperature burdens and relocation of R.C. encircled structures. In this perspective considered the impact of development joints in basic conduct of RC surrounded normal and unpredictable structures. For this reason considered four distinct sorts of RC surrounded structures (C,T,L and Rectangular) for every situation analyzed the parallel considering so as to uproot and amount of steel with and without extension joints by utilizing PC programming STAAD Pro.

Key words- STAAD, CTL, structural behavior.

I. Introduction

The expression "extension joint" as utilized alludes to the detachment joints gave inside of a Building to allow the different fragments of the auxiliary casing to extend and contract in light of Temperature changes without antagonistically influencing the building's basic uprightness or serviceability. The typical practice in runways, scaffolds, structures and street development is to give extension joints between cutting chunks of fortified cement at planning interims and at convergences with different developments. These joint filers are then secured with fixing mixes. Concrete extends somewhat when the temperature rises. Likewise, solid psychologists after drying and develops consequent wetting. Procurement must provide food for the volume change by method for joint to assuage the anxieties created. An Expansion joint is really a crevice, which permits space for a working to move all through. The development of the building is created most as often as possible by temperature changes, the measure of extension and withdrawal of building relies on the sort of material it is built out of. A steel encircled building will move by an alternate sum then a solid surrounded one. If there should be an occurrence of a little building, the extent of development is less and in this way, no joint is required either in the floor or rooftop piece. Be that as it may, if there should be an occurrence of the long building, the development is expansive and might be as much as 25 mm. In this way, structures longer than 45 m are by and large furnished with one or more extension joints. Having fruitful determination the anticipated development along the three main hub of the Expansion joint hole, the fashioner and Specifier are currently confronted with a more basic decision, that of picking of material to seal the joint crevice itself from the component. This is a specific imperative building envelope plan thought, particularly when dampness and water are available.

II. LITERATURE SURVEY

GENERAL

Numerous studies have come with respect to development joints of structures yet not very many studies were demonstrated the impact of extension joints. In any case, in late year's examination action in this field of development joints are considered. In this study the impact of development joints was done under various sorts of unpredictable structures (i.e. C, T, L and Rectangular sort) and contrasted the structures and Expansion joints and without Expansion joints subjected to temperature stresses.

Prior STUDIES

Michael J. Pfeiffer, David Darwin13 (1987) is talked about the development, compression and extension joints in fortified solid structures. They are tended to the reason for every sort of joint and underscores the choice of joint areas and joint dispersing. A few parts of joint setup and development are additionally secured. Observational and systematic configuration methods are displayed.

HERBERT H. SWINBURNE2 (2000) the study was completed under the heading of the Federal Construction Council Standing Committee on Structural Engineering. The Committee initially analyzed in subtle element an unpublished report in which even changes in measurement in nine government structures were watched and identified with recorded temperature changes. Moreover, the Committee considered the present practices of government offices with respect to extension joint criteria. To upgrade its comprehension of the dispersion of hassles and related misshapening in casings subjected to uniform temperature change, the Committee detailed and led aninvestigative investigation of the impacts of uniform temperature change on run of the mill two-dimensional versatile edges. A hypothetical PC model was created for this reason. Watched dimensional changes brought on by temperature changes were corresponded with information acquired from the PC examination. The aftereffects of the Committee's study and examination, and additionally its aggregate experience and judgment, served as the bases for this report.

Stipend T. Halvorsen12 (2001), all structures are limited to some degree; this restriction will impel stresses with temperature changes. Temperature prompted anxieties are relative to the temperature change. Huge temperature varieties can bring about considerable hassles to represent in outline. Little temperature changes might bring about immaterial burdens.

James M. Fisher, S.E10. (2005) he has encountered a few issues in respect to development challenges connected with extension joints. The first is that temperature changes to which an unenclosed unheated structure is subjected to amid development might surpass the configuration temperature changes after culmination of the structure. These expanded temperature changes ought to be considered by the planner. The temperature to be considered amid development, obviously, differs relying on building area. Now and then it is extremely troublesome for the steel erector to conform the development joint at the coveted area, as ordinary erection resiliences might compel the extension joint to one end of its travel. This issue can be disposed of if the fashioner considers a subtle element at the most distant end of the part to which the development joint is situated, as a method for change. Along these lines, the development resistance can be adjusted

A.Plumier, V. Denoël, L. Sanchez, C. Doneux, V. Warnotte1, (2007) a versatile investigation of a current 20-story strengthened solid minute opposing casing isolated in 3 pieces demonstrates that shafts bolstered on corbels of the nearby square at the development joint lose their backing when every free piece vibrate all alone under tremor. Diverse reconnection theory were viewed as, extending from altering absolutely every square to the contiguous one to more adaptable choices abandoning some free relative move between pieces. A flexible modular superposition took after by a sucker investigation considering the last reconnection guideline were made. The degrees of opportunity of the joint reconnections were seen to be a critical parameter. The arrangement discovered leaves a free relative rotational move in the middle of squares and an adaptable translational development, so that strengths at the association don't turn out to be pointlessly high.

Matthew D. Brady, P.E12. (2011) all structures are subjected to development and contraction because of the warm loads from introduction to changes in the encompassing temperature, both amid development and in operation. Nearby climate designs alongside the warming and aerating and cooling of atmosphere controlled spaces will manage the temperatures to which the structure is subjected. While these adjustments in temperature regularly occur gradually, the impacts are the same. Hotter materials grow and colder materials contract. Contingent upon the expected temperature variety and materials utilized, development joints ought to be utilized as a part of all structures surpassing the lengths

SPEIGHT, MARSHALL and FRANCIS15, (2012) Buildings are liable to dimensional changes created by a variety of temperatures. Appropriately assessing the measure of level development, coming about because of warm loads all through of the life of the building, is one of the more intricate errands amid the outline process. If not appropriately tended to, the inward burdens created by warm loads will discover a system for discharge, and can bring about exorbitant breaking. An extension joint is a controlled instrument permitting a structure to move all in all and keep the differential development of segments to a base. This will guarantee weak cladding, especially workmanship, is not subjected to over the top relocations and weighty detachment or splitting, along these lines permitting water to enter into inside spaces

SANJAY SHIRKE, H.S.CHORE, P.A. DODE14 (2014) Long structures with no extension joints has turned into a need in perspective of requesting building design and present Industrial pattern. According to Indian Standard code, IS-456:2000, structures longer than 45m should be investigated for the warm hassles and fitting measures might be taken amid altering the auxiliary framework. Notwithstanding, IS codes are noiseless as far as procedure to follow in such sort of plans and in addition on burden elements to be considered in outline blend of temperature burden with gravity loads. To compound the circumstance, there are no rules accessible with the configuration architects to touch base at outline temperature esteem that ought to be considered in working out warm burdens. Three multilevel auto park structures are investigated here keeping in mind the end goal to consider the impact of temperature burden concerning length of building. Structures considered are of length approx. 80m, 160m and 240m. This paper covers the impact of temperature burden on strengths experienced by bars and general fortification utilization.

Farhana M. Saiyed, Ashish H. Makwana, Jayeshkumar Pitroda3 (2014) in spite of the fact that structures are regularly developed utilizing adaptable materials, rooftop and auxiliary extension joints are required when arrangement measurements are expansive. It is unrealistic to state definite prerequisites with respect to removes between extension joints as a result of the numerous variables included, for example, surrounding temperatures amid development and the normal temperature range amid the life of a building. Extension joints are intermittent breaks in the structure of the structures. A development joint is a gathering intended to securely assimilate the warmth affected extension and compression of different development materials. They are normally found between areas of pieces, scaffolds, and different structures. The "get together" can be as straightforward as a caulked detachment between two areas of the same materials. All the more as of late, development joints have been incorporated into the configuration of, or added to existing, block outside dividers for comparable purposes. Consistently, constructing faces and solid pieces will grow and contract because of the warming and cooling of our planet through the seasons. The structures would break under the anxiety of warm extension and constriction if development joint crevices were not incorporated with the structures. Indeed, even today the extension joint holes are frequently ignored amid the configuration process. This straightforward caulking can't deal with the warm extension because of the evolving seasons, at last leaving a whole point in the structures.

III. THEORY/METHODOLOGY

GENERAL

In this chapter, discussed about model specifications, modeling of structures, loads and load combinations. And also to give brief overview of study flow chart was prepared.

BASIC MODEL SPECIFICATIONS

Building type :RC frames with and without expansion joints

for “C”, “T”, “L”, and RECTANGULAR type buildingsFloor area

“C” type : 78.81M X 30.26 Meters

“T” type : 65.25M X 30.26 Meters

“L” type : 75.18M X 30.26 Meters

“RECTANGULAR” type : 88.41M X 10.68 Meters

Storey Height: 3m

No. of Stories: G+4.

- Comparison of displacements of both the structures with and without expansion joints were done by doing analysis in STAAD PRO.

MATERIAL PROPERTIES

- The material used for analysis is reinforced concrete with M-20 grade concrete and Fe-415 grade reinforcing steel.
- The Stress-strain relationship used is as per IS 456-2000. The basic material properties are as follows:

Modulus of Elasticity of steel, Es = 20,000MPa

Ultimate strain in bending, ∑cu = 0.0035

Characteristic strength of concrete, f_{ck} = 20MPa

Yield stress for steel, f_y = 415Mpa

MODELLING OF STRUCTURE

A regular RC frame structure is chosen with and without expansion joints, the plan of the apartment shown in figure and the structure was modeled for G+4 storey. All the considered frames are assumed to be fixed at ground level and storey heights are taken as 3m . All the members of the structure are assumed to be homogenous isotropic and having elastic modulus same in compression as well as in tension.

Constant beam and column sizes were taken at all floor levels for each considered frame , however sizes of columns and beams vary with respect to number of storeys. sizes of structural members shown in table given below:

TableSizes of structural members for G+4 storey’s

MEMBER	SIZE(mm)
Beam	230X450
Column	230X450
Slab thickness	150

IV. ANALYSIS AND DESIGN RESULTS

From the study obtained the lateral displacements for limit state of serviceability condition.

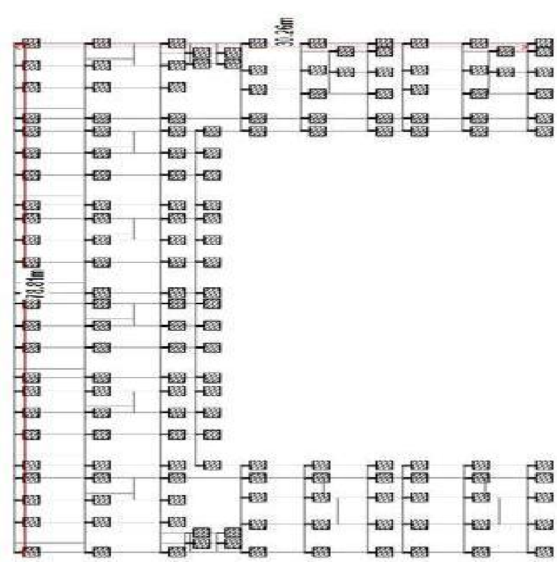

Fig:-Plan showing “C” type residential building without expansion joints

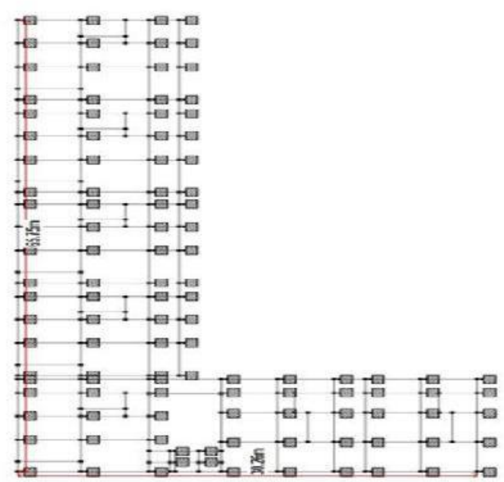

Fig: -Plan showing “L” type residential building with expansion joints

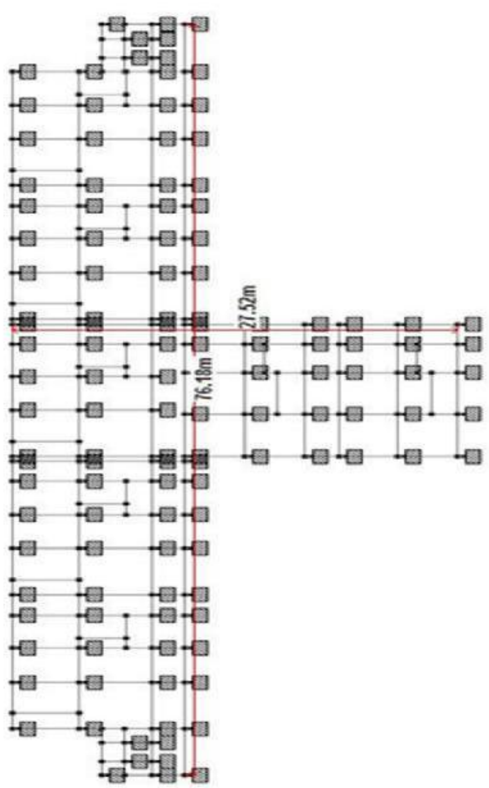

Fig: -Plan showing “T” type residential building with expansion joints

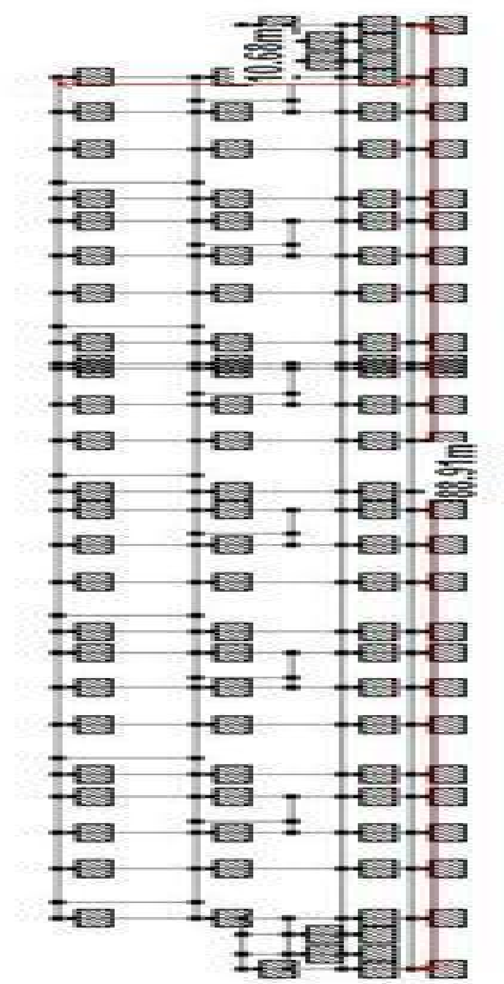

Fig:-Plan showing “rectangular” type residential building with expansion joints

V. RESULTS AND DISCUSSIONS

GENERAL

Failure of structure starts at points of weakness. This weakness arises due to discontinuity is mass, stiffness and geometry of structure. The structure having the discontinuity are termed as irregular structures. In this study, a RC space frame (i.e. “C”, “T”, “L”, “RECTANGULAR” type buildings) with and without expansion joints has been analyzed. By considering for G+4 storey at different temperature stresses using STAAD Pro. Variation in percentage of displacements and quantities of steel of these structure are discussed below:

COMPARISON OF LATERAL DISPLACEMENT OF RC FRAMES

COMPARSION FOR "C" TYPE BUILDING

Comparison of lateral displacement of frames with Expansion joint and without expansion joint subjected to temperature stress (varying temperature of 20^{0}C, 30^{0}C, 40^{0}C)

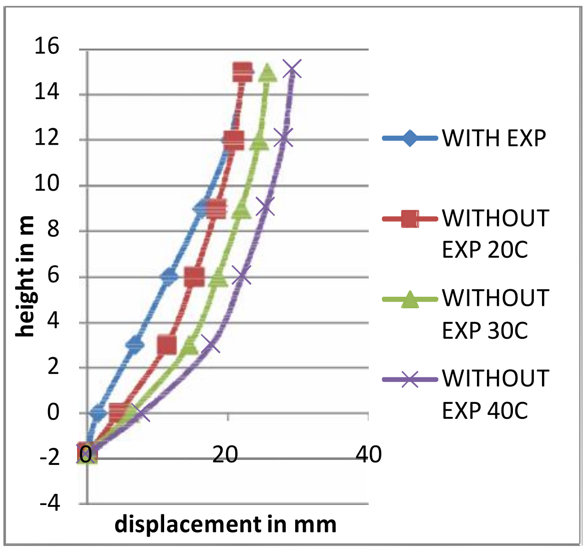

Fig. Comparison of lateral displacement of frames with Expansion joint and without expansion joint subjected to temperature stress (varying temperature of 20^{0}C, 30^{0}C, 40^{0}C)

From the Fig, it was observed that there was an decrease of 1.5% and increase of 14.2% and 30.07% in lateral displacement for frames with Expansion joint when compared to structure without expansion joint subjected to temperature stress (varying temperature of 20^{0}C, 30^{0}C, 40^{0}C)

COMPARSION FOR "L" TYPE BUILDING

Comparison of lateral displacement of frames with Expansion joint and without expansion joint subjected to temperature stress (varying temperature of 20^{0}C, 30^{0}C, 40^{0}C)

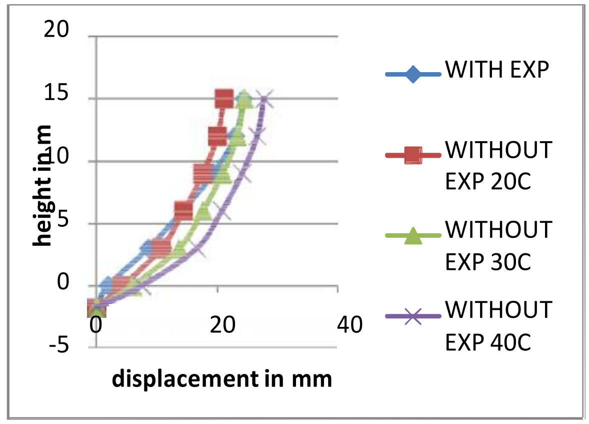

Fig. Comparison of lateral displacement of frames with Expansion joint and without expansion joint subjected to temperature stress (varying temperature of 20^{0}C, 30^{0}C, 40^{0}C)

From the Fig, it was observed that there was an decrease of 13.2% and increase of 0.26% and 13.75% in lateral displacement for frames with Expansion joint when compared to structure without expansion joint subjected to temperature stress (varying temperature of 20^{0}C, 30^{0}C, 40^{0}C)

FOR "T" TYPE BUILDING

Comparison of lateral displacement of frames with Expansion joint and without expansion joint subjected to temperature stress (varying temperature of 20^{0}C, 30^{0}C, 40^{0}C)

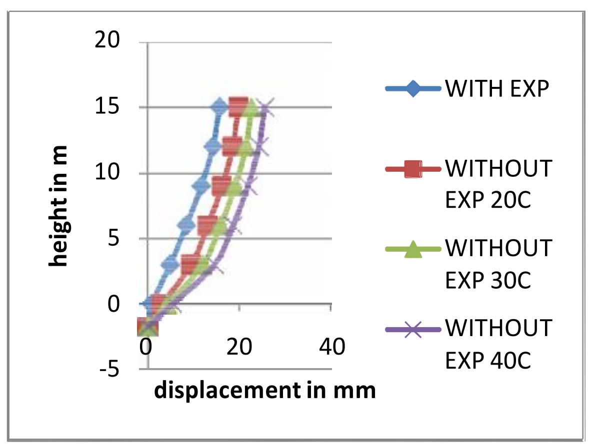

Fig. Comparison of lateral displacement of frames with Expansion joint and without expansion joint subjected to temperature stress (varying temperature of 20^0C, 30^0C, 40^0C)

From the Fig, it was observed that there was an increase in lateral displacement of 25.77%, 44.10% and 62.43% for frames with Expansion joint when compared to structure without expansion joint subjected to temperature stress (varying temperature of 20^0C, 30^0C, 40^0C)

COMPARSION FOR "RECTANGULAR" TYPE BUILDING

Comparison of lateral displacement of frames with Expansion joint and without expansion joint subjected to temperature stress (varying temperature of 20^0C, 30^0C, 40^0C)

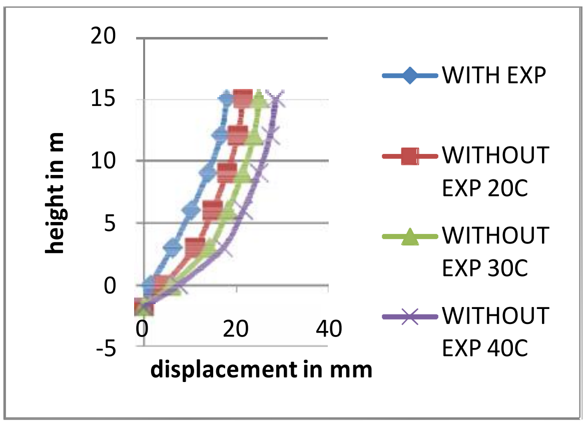

Fig. Comparison of lateral displacement of frames with Expansion joint and without expansion joint subjected to temperature stress (varying temperature of 20^0C, 30^0C, 40^0C)

From the Fig, it was observed that there was an increase in lateral displacement of 19.42%, 38.8% and 58.21% for frames with Expansion joint when compared to structure without expansion joint subjected to temperature stress (varying temperature of 20^0C, 30^0C, 40^0C)

VI. COMPARSION OF QUANTITY OF STEEL

Comparsion of quantities of steel in frames with Expansion joints and without Expansion joints subjected to temperature stress (varying temperatures of 20^0C, 30^0C and 40^0C).

FOR C TYPE BUILDING

Table: quantities of steel for frame with expansion joints and without expansion joints subjected to temperature stresses (varying temperatures of 20^0C, 30^0C and 40^0C).

Type	Frame with expansion joint	Frame without expansion joint subjected to Temperature stresses of		
		20^0c	30^0c	40^0c
quantity of steel	86.155	153.145	157.09	158.258

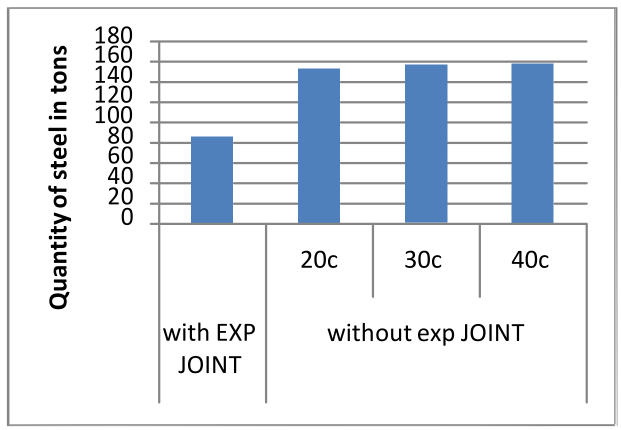

Fig comparison quantities of steel for frame with expansion joints and without expansion joints subjected to temperature stresses (varying temperatures of 20^0C, 30^0C and 40^0C).

From the figure 4.29, when compared to R.C frame with expansion joints and without expansion joint subjected to temperature stresses (i.e. varying temperature of 20^0C, 30^0C and 400C), there was a increase in percentage of steel of 77.75, 82.33 and 83.68 respectively.

FOR L TYPE BUILDING

Table: quantities of steel for frame with expansion joints and without expansion joints subjected to temperature stresses (varying temperatures of 20^0C, 30^0C and 40^0C).

Type	Frame with expansion joint	Frame without expansion joint subjected to Temperature stresses of		
		20^0c	30^0c	40^0c
quantity of steel (Ton)	61.056	107.52	109.44	110.321

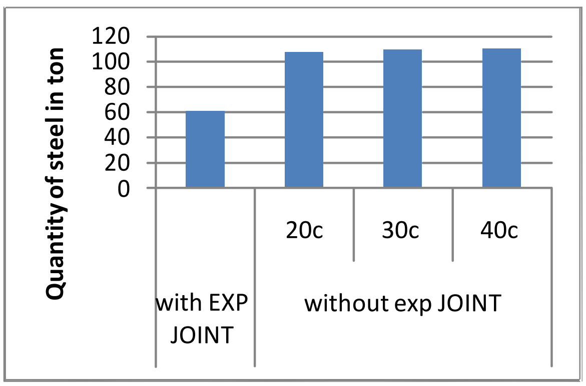

Fig comparison quantities of steel for frame with expansion joints and without expansion joints subjected to temperature stresses (varying temperatures of 20^0C, 30^0C and 40^0C).

From the figure 4.30, when compared to R.C frame with expansion joints and without expansion joint subjected to temperature stresses (i.e. varying temperature of 20^0C,30^0C and 40^0C), there was a increase in percentage of steel of 76.1, 79.24 and 80.68 respectively.

FOR T TYPE BUILDING

Table: quantities of steel for frame with expansion joints and without expansion joints subjected to temperature stresses (varying temperatures of 20^0C, 30^0C and 40^0C).

Type	Frame with expansion joint	Frame without expansion joint subjected to Temperature stresses of		
		20^0c	30^0c	40^0c
quantity of steel (ton)	64.893	61.7	61.25	61.357

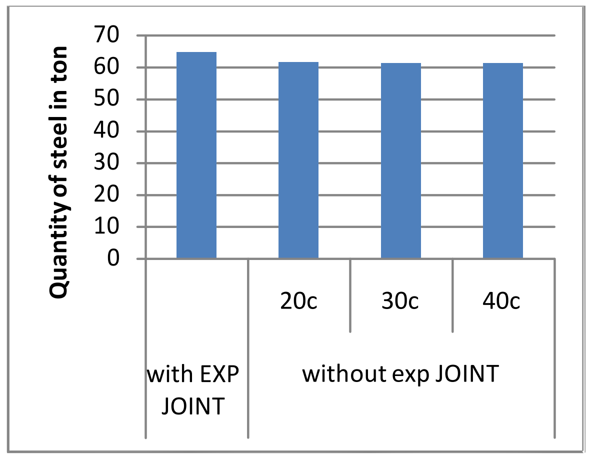

Fig comparison quantities of steel for frame with expansion joints and without expansion joints subjected to temperature stresses(varying temperatures of 20^0C, 30^0C and 40^0C).

From the figure, when compared to R.C frame with expansion joints and without expansion joint subjected to temperature stresses (i.e. varying temperature of 20^0C,30^0C and 40^0C), there was a decrease in percentage of steel of 4.9, 5.61 and 5.44 respectively.

FOR RECTANGULAR TYPE BUILDING

Table : quantities of steel for frame with expansion joints and without expansion joints subjected to temperature stresses (varying temperatures of 20^0C, 30^0C and 40^0C).

Type	Frame with expansion joint	Frame without expansion joint subjected to Temperature stresses of		
		20^0c	30^0c	40^0c
quantity of steel (ton)	60.06	59.514	59.76	59.47

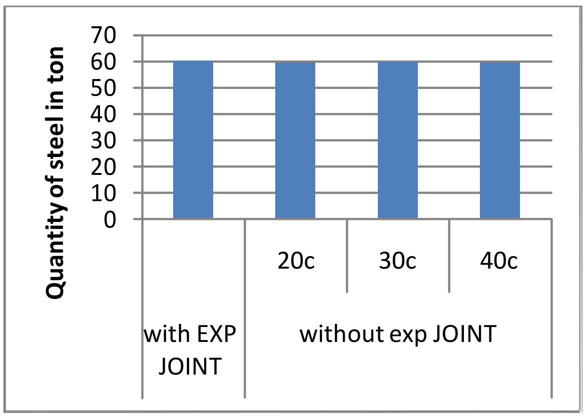

Fig comparison quantities of steel for frame with expansion joints and without expansion joints subjected to temperature stresses (varying temperatures of 20^0C, 30^0C and 40^0C).

From the figure, when compared to R.C frame with expansion joints and without expansion joint subjected to temperature stresses (i.e. varying temperature of 20^0C,30^0C and 40^0C), there was a slightly decrease in percentage of steel of 0.909, 0.49 and 0.98 respectively.

VII. CONCLUSIONS

The lateral displacements and quantity of steel for Regual and Irregular R.C framed structures with and without expansion joints were investigated using the linear static analysis. Following were the conclusions drawn from the study.

1. For "C" type G+4 storey building, it was observed, when compared to frame with expansion joint to frame without expansion joints, there was an decrease in percentage of lateral displacement of 4.17 at a temperature stress of 20^0c and there was an increase in percentage of lateral displacements of 10.73 and 25.236 at a temperature stresses of 30^0c and 40^0c respectively.

2. For "L" type G+4 storey building, it was observed, when compared to frame with expansion joint to frame without expansion joints, there was an decrease in percentage of lateral displacements of 17.18 and 4.865 at a temperature stresses of 20^0c and 30^0c and there was an increase in percentage of lateral displacement of 7.45 at a temperature stresses of 40^0c respectively.

3. For "T" type G+4 storey building, it was observed, when compared to frame with expansion joint to frame without expansion joints, there was an increase in percentage of lateral displacement of 26.84, 44.63 and 62.41 at a temperature stresses of 20^0c, 30^0c and 40^0c respectively.

4. For "Rectangular" type G+4 storey building, it was observed, when compared to frame with expansion joint to frame without expansion joints, there was an increase in percentage of lateral displacement of 21.49, 40.619 and 59.74 at a temperature stresses of 20^0c, 30^0c and 40^0c respectively.

5. For "C" type building it was observed, when compared to frame with and without expansion joint subjected to temperature stresses (i.e. varying temperatures of 20^0c, 30^0c and 40^0c) there was an increase in percentage of steel of 77.75, 82.33 and 83.68 respectively.

6. For "L" type building it was observed, when compared to frame with and without expansion joint subjected to temperature stresses (i.e. varying temperatures of 200c, 30^0c and 40^0c) there was an increase in

percentage of steel of 76.1, 79.24 and 80.68 respectively.

7. For "T" type building it was observed, when compared to frame with and without expansion joint subjected to temperature stresses (i.e. varying temperatures of 200c, 30^0c and 40^0c) there was a decrease in percentage of steel of 4.9, 5.61 and 5.44 respectively.

8. For "Rectangular" type building it was observed, when compared to frame with and without expansion joint subjected to temperature stresses (i.e. varying temperatures of 200c, 30^0c and 40^0c) there was an decrease in percentage of steel of 0.9, 0.49 and 0.98 respectively.

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